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(54) **AUTOFOCUS METHOD, DEVICE AND ELECTRONIC APPARATUS**

AUTOFOKUSVERFAHREN, VORRICHTUNG UND ELEKTRONISCHE VORRICHTUNG

PROCÉDÉ, DISPOSITIF ET APPAREIL ÉLECTRONIQUE AUTOFOCUS

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(56) References cited:
WO-A1-2013/146996
WO-A1-2014/044126
CN-A- 101 025 546
CN-A- 101 813 867
CN-A- 103 905 709
CN-A- 103 986 876
US-A- 4 185 191
US-A1- 2008 218 612
US-A1- 2010 328 432
US-A1- 2014 210 953
US-B2- 8 284 294

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Description

TECHNICAL FIELD

[0001] This application relates to the field of electronic technologies, and in particular, to an auto-focus method and apparatus, and an electronic device.

BACKGROUND

[0002] Auto-focus refers to controlling a distance from a lens to an image sensor by using an auto-focus algorithm, so that a subject of a to-be-photographed object reaches a clearest state.

[0003] Commonly used focus algorithms may be classified into two types: active focusing (a distance measurement method) and passive focusing (a hill climbing method). In active focusing, a distance from a photographed subject to a lens is measured by using a method such as infrared distance measurement, ultrasonic distance measurement, and binocular stereoscopic vision, a lens position corresponding to an object distance is calculated, and the lens position is adjusted to obtain an image in focus. In passive focusing, images with different focal lengths are obtained by changing focal lengths, definition and change trends of the images are analyzed, an optimal focal length is found, to obtain an image in focus. Currently, a passive focusing solution is widely used in an electronic device such as a smartphone. A speed of active focusing is fast, but in a specific scenario, a focusing failure rate is high. Precision of passive focusing is high, but a focusing speed is slow.

WO 2013/146996 A1 discloses image acquisition means for acquiring multiple viewpoint images that are generated by pupil-division imaging and that are different in viewpoint, parallax calculation means for calculating a first parallax amount between viewpoint images for the multiple viewpoint images, a memory in which parallax correction information indicating the relationship between the first parallax amount and the deviation amount in the parallax direction for the corresponding object images, which is a deviation amount between viewpoint images for the multiple viewpoint images and is caused by the pupil-division imaging, is stored, and parallax correction means for calculating a second parallax amount, which is an amount resulting from correcting the first parallax amount to the deviation amount in the parallax direction for the object images, based on the first parallax amount and the parallax correction information stored in the memory.

WO 2014/044126 A1 discloses a computer vision-based system and method for real-time 3D object reconstruction, a 3D coordinate information acquisition device used therefor, and a stereoscopic interactive device. The coordinate acquisition device comprises: an image acquisition module used for shooting the same target object through a first camera and a second camera of an infrared binocular video camera so as to respectively obtain a first image and a second image; an area selection module used for determining an area of interest in the first image based on an image greyscale feature; an edge point extraction module used for extracting an edge point for the area of interest; and a depth calculation module used for searching for a matching point corresponding to the edge point of the first image in the second image and obtaining a 3D coordinate of the matching point according to the coordinate of the edge point and the coordinate of the matching point. The solution provided in the present application is applicable to short-range 3D object reconstruction.

US 2014/210953 A1 discloses an image display apparatus that includes: a stereoscopic image obtaining unit which obtains a plurality of images having different points of view; a display unit which displays the plurality of images; a photographic subject selecting unit which selects a specific photographic subject in any one of the plurality of images; and a display controller which displays a line where a parallax amount of a first viewpoint image and a second viewpoint image among the plurality of images is zero and an anteroposterior relationship of the line where the parallax amount is zero and a position of the specific photographic subject in an optical axis direction in photographing a stereoscopic image in a partial display region of the display unit as a pseudo overhead view of the photographic subject which is seen from an upper side with respect to the optical axis in photographing the stereoscopic image.

SUMMARY

[0004] Embodiments of this application provide an auto-focus method as defined in independent claim 1, and an electronic device as defined in independent claim 8 to improve focusing precision of active focusing.

[0005] A first aspect of this application provides an auto-focus method, including:

at a same moment, collecting a first image of a first object by using a first image shooting unit, and collecting a second image of the first object by using a second image shooting unit;
calculating M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image, where M is a positive integer;
determining whether confidence of the M pieces of first depth information is greater than a threshold;
obtaining focusing depth information according to N pieces of first depth information in the M pieces of first depth information when the confidence of the M pieces of first depth information is greater than the threshold, where N is a positive integer less than or equal to M; and
obtaining a target position of a first lens of the first image shooting unit according to the focusing depth information, and controlling the first lens to move to

the target position.

[0006] With reference to the first aspect, in a first possible implementation manner of the first aspect, the corresponding areas are areas corresponding to positions of focus windows when the first image and the second image are collected, an area in the first image is a first area, an area in the second image is a second area, and the determining whether confidence of the M pieces of first depth information is greater than a threshold includes:
determining whether a quantity of first feature points in the first area is greater than or equal to a first threshold or determining whether a quantity of second feature points in the second area is greater than or equal to a second threshold, and when the quantity of first feature points is less than the first threshold and/or the quantity of second feature points is less than the second threshold, determining that the confidence of the M pieces of first depth information is less than or equal to the threshold.

[0007] With reference to the first possible implementation manner of the first aspect, in a second possible implementation manner of the first aspect, when the quantity of first feature points is greater than or equal to the first threshold and the quantity of second feature points is greater than or equal to the second threshold, the method further includes:

for the first feature points, searching the second feature points in a first sequence for first matching feature points that match the first feature points, and searching the second feature points in a second sequence for second matching feature points that match the first feature points, where the second sequence is reverse to the first sequence;
determining a quantity of same matching feature points that are in the first matching feature points and the second matching feature points and that are corresponding to a same feature point in the first feature points; and
when a proportion of the quantity to the quantity of first feature points is less than a third threshold, determining that the confidence of the M pieces of first depth information is less than or equal to the threshold; or
when a proportion of the quantity to the quantity of first feature points is greater than or equal to a third threshold, determining that the confidence of the M pieces of first depth information is greater than the threshold.

[0008] With reference to the second possible implementation manner of the first aspect, in a third possible implementation manner of the first aspect, the obtaining focusing depth information according to N pieces of first depth information in the M pieces of first depth information includes:
obtaining the focusing depth information according to depth information corresponding to the same feature point.

[0009] With reference to the first aspect or any one of the first possible implementation manner of the first aspect to the third possible implementation manner of the first aspect, in a fourth possible implementation manner of the first aspect, after the controlling the first lens to move to the target position, the method further includes:

controlling a second lens of the second image shooting unit to move to a third position;
determining that a check on the focusing depth information succeeds when a first contrast that is of an image obtained before the first lens moves to the target position and that is in a focus window area is less than a second contrast that is of an image obtained when the first lens is at the target position and that is in a focus window area, and a third contrast that is of an image obtained when the second lens is at the third position and that is in a focus window area is less than the second contrast; and
performing image shooting at the target position.

[0010] With reference to the first aspect or any one of the first possible implementation manner of the first aspect to the third possible implementation manner of the first aspect, in a fifth possible implementation manner of the first aspect, before the controlling the first lens to move to the target position, the method further includes:
determining that a check on the focusing depth information is successful.

[0011] With reference to the fifth possible implementation manner of the first aspect, in a sixth possible implementation manner of the first aspect, when a human face is detected in the focus window, the check is performed on the focusing depth information by using the following steps:

estimating an estimated distance between the human face and the first lens according to a size of a human face frame; and
determining that the check on the focusing depth information is successful when an absolute value of a difference between the estimated distance and the focusing depth information is less than or equal to a fourth threshold.

[0012] With reference to any one of the fourth possible implementation manner of the first aspect to the sixth possible implementation manner of the first aspect, in a seventh possible implementation manner of the first aspect, when the confidence of the M pieces of first depth information is less than or equal to the threshold or the check fails, the method further includes:

controlling the first lens and the second lens of the second image shooting unit to move to new positions;

at the new positions, collecting, at a same time, a third image and a fourth image that are of the first object respectively by using the first image shooting unit and the second image shooting unit;

calculating P pieces of second depth information of P same feature point pairs in corresponding areas in the third image and the fourth image, where P is a positive integer;

determining whether confidence of the P pieces of second depth information is greater than the threshold;

obtaining new focusing depth information according to L pieces of second depth information in the P pieces of second depth information when the confidence of the P pieces of second depth information is greater than the threshold, wherein L is a positive integer less than or equal to P; and

obtaining a new target position of the first lens according to the new focusing depth information, and controlling the first lens to move to the new target position.

[0013] With reference to the first aspect, any one of the first possible implementation manner of the first aspect to the third possible implementation manner of the first aspect, the fifth possible implementation manner of the first aspect, or the sixth possible implementation manner of the first aspect, in an eighth possible implementation manner of the first aspect, when the first lens is controlled to move to the target position, the method further includes:

controlling a second lens of the second image shooting unit to move to a position corresponding to the target position.

[0014] A second aspect of this application provides an auto-focus apparatus, including:

an acquiring unit, configured to obtain a first image that is of a first object and collected by using a first image shooting unit, and a second image that is of the first object and collected by using a second image shooting unit, where the first image and the second image are collected at a same moment; and

a processing unit, configured to: calculate M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image, where M is a positive integer; determine whether confidence of the M pieces of first depth information is greater than a threshold; obtain focusing depth information according to N pieces of first depth information in the M pieces of first depth information when the confidence of the M pieces of first depth information is greater than the threshold, where N is a positive integer less than or equal to M; and obtain a target position of a first lens of the first image shooting unit according to the focusing depth information, and control the first lens to move to the target position.

[0015] With reference to the second aspect, in a first possible implementation manner of the second aspect, the corresponding areas are areas corresponding to positions of focus windows when the first image and the second image are collected, an area in the first image is a first area, an area in the second image is a second area, and the processing unit is specifically configured to: determine whether a quantity of first feature points in the first area is greater than or equal to a first threshold or determine whether a quantity of second feature points in the second area is greater than or equal to a second threshold, and when the quantity of first feature points is less than the first threshold and/or the quantity of second feature points is less than the second threshold, determine that the confidence of the M pieces of first depth information is less than or equal to the threshold.

[0016] With reference to the first possible implementation manner of the second aspect, in a second possible implementation manner of the second aspect, the processing unit is further configured to: when the quantity of first feature points is greater than or equal to the first threshold and the quantity of second feature points is greater than or equal to the second threshold, for the first feature points, search the second feature points in a first sequence for first matching feature points that match the first feature points, and search the second feature points in a second sequence for second matching feature points that match the first feature points, where the second sequence is reverse to the first sequence;

determine a quantity of same matching feature points that are in the first matching feature points and the second matching feature points and that are corresponding to a same feature point in the first feature points; and

when a proportion of the quantity to the quantity of first feature points is less than a third threshold, determine that the confidence of the M pieces of first depth information is less than or equal to the threshold; or

when a proportion of the quantity to the quantity of first feature points is greater than or equal to a third threshold, determine that the confidence of the M pieces of first depth information is greater than the threshold.

[0017] With reference to the second possible implementation manner of the second aspect, in a third possible implementation manner of the second aspect, the processing unit is specifically configured to obtain the focusing depth information according to depth information corresponding to the same feature point.

[0018] With reference to the second aspect or any one of the first possible implementation manner of the second aspect to the third possible implementation manner of the second aspect, in a fourth possible implementation manner of the second aspect, the processing unit is further configured to: after controlling the first lens to move to the target position, control a second lens of the second image shooting unit to move to a third position; determine that a check on the focusing depth information succeeds when a first contrast that is of an image obtained before the first lens moves to the target position and that is in a focus window area is less than a second contrast that is of an image obtained when the first lens is at the target position, and a third contrast that is of an image obtained when the second lens is at the third position and that is in a focus window area is less than the second contrast; and control performing image shooting at the target position.

[0019] With reference to the second aspect or any one of the first possible implementation manner of the second aspect to the third possible implementation manner of the second aspect, in a fifth possible implementation manner of the second aspect, the processing unit is further configured to: before controlling the first lens to move to the target position, determine that a check on the focusing depth information is successful.

[0020] With reference to the fifth possible implementation manner of the second aspect, in a sixth possible implementation manner of the second aspect, the processing unit is specifically configured to: when a human face is detected in the focus window, estimate an estimated distance between the human face and the first lens according to a size of a human face frame; and determine that the check on the focusing depth information is successful when an absolute value of a difference between the estimated distance and the focusing depth information is less than or equal to a fourth threshold.

[0021] With reference to any one of the fourth possible implementation manner of the second aspect to the sixth possible implementation manner of the second aspect, in a seventh possible implementation manner of the second aspect, the processing unit is further configured to: when the confidence of the M pieces of first depth information is less than or equal to the threshold or the check fails, control the first lens and the second lens of the second image shooting unit to move to new positions;

the acquiring unit is further configured to obtain, at the new positions, a third image and a fourth image that are of the first object and collected at a same time respectively by using the first image shooting unit and the second image shooting unit; and

the processing unit is further configured to: calculate P pieces of second depth information of N same feature point pairs in corresponding areas in the third image and the fourth image, where P is a positive integer; determine whether confidence of the P pieces of second depth information is greater than the threshold; obtain new focusing depth information according to L pieces of second depth information in the P pieces of second depth information when the confidence of the P pieces of second depth information is greater than the threshold, where L is a positive integer less than or equal to P; and obtain a new target position of the first lens according to the new focusing depth information, and control the first lens to move to the new target position.

[0022] With reference to the second aspect, any one of the first possible implementation manner of the second aspect to the third possible implementation manner of the second aspect, the fifth possible implementation manner of the second aspect, or the sixth possible implementation manner of the second aspect, in an eighth possible implementation manner of the second aspect, the processing unit is further configured to: when controlling the first lens to move to the target position, control a second lens of the second image shooting unit to move to a position corresponding to the target position.

[0023] A third aspect of this application provides an electronic device, including:

a first image shooting unit and a second image shooting unit, configured to respectively collect, at a same moment, a first image and a second image that are of a first object;

a first actuator; and

a processor, configured to: calculate M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image, where M is a positive integer; determine whether confidence of the M pieces of first depth information is greater than a threshold; obtain focusing depth information according to N pieces of first depth information in the M pieces of first depth information when the confidence of the M pieces of first depth information is greater than the threshold, where N is a positive integer less than or equal to M; and obtain a target position of a first lens of the first image shooting unit according to the focusing depth information, and control the first actuator to move, so that the first lens moves to the target position.

[0024] With reference to the third aspect, in a first possible implementation manner of the third aspect, the corresponding areas are areas corresponding to positions of focus windows when the first image and the second image are collected, an area in the first image is a first area, an area in the second image is a second area, and the processor is specifically configured to: determine whether a quantity of first feature points in the first area is greater than or equal to a first threshold or determine whether a quantity of second feature points in the second area is greater than or equal to a second threshold, and when the quantity of first feature points is less than the first threshold and/or the quantity of second feature points is less than the second threshold, determine that the confidence of the M pieces of first depth information is less than or equal to the threshold.

[0025] With reference to the first possible implementation manner of the third aspect, in a second possible implementation manner of the third aspect, the processor is further configured to: when the quantity of first feature points is greater than or equal to the first threshold and the quantity of second feature points is greater than or equal to the second threshold, for the first feature points, search the second feature points in a first sequence for first matching feature points that match the first feature points, and search the second feature points in a second sequence for second matching feature points that match the first feature points, where the second sequence is reverse to the first sequence;

determine a quantity of same matching feature points that are in the first matching feature points and the second matching feature points and that are corresponding to a same feature point in the first feature points; and

when a proportion of the quantity to the quantity of first feature points is less than a third threshold, determine that the confidence of the M pieces of first depth information is less than or equal to the threshold; or

when a proportion of the quantity to the quantity of first feature points is greater than or equal to a third threshold, determine that the confidence of the M pieces of first depth information is greater than the threshold.

[0026] With reference to the second possible implementation manner of the third aspect, in a third possible implementation manner of the third aspect, the processor is specifically configured to obtain the focusing depth information according to depth information corresponding to the same feature point.

[0027] With reference to the third aspect or any one of the first possible implementation manner of the third aspect to the third possible implementation manner of the third aspect, in a fourth possible implementation manner of the third aspect, the electronic device further includes a second actuator, and the processor is further configured to: after controlling the first lens to move to the target position, control the second actuator to move, so as to move a second lens of the second image shooting unit to a third position; determine that a check on the focusing depth information succeeds when a first contrast that is of an image obtained before the first lens moves to the target position and that is in a focus window area is less than a second contrast that is of an image obtained when the first lens is at the target position and that is in a focus window area, and a third contrast that is of an image obtained when the second lens is at the third position and that is in a focus window area is less than the second contrast; and control performing image shooting at the target position.

[0028] With reference to the third aspect or any one of the first possible implementation manner of the third aspect to the third possible implementation manner of the third aspect, in a fifth possible implementation manner of the third aspect, the processor is further configured to: before controlling the first lens to move to the target position, determine that a check on the focusing depth information is successful.

[0029] With reference to the fifth possible implementation manner of the third aspect, in a sixth possible implementation manner of the third aspect, the processor is specifically configured to: when a human face is detected in the focus window, estimate an estimated distance between the human face and the first lens according to a size of a human face frame; and determine that the check on the focusing depth information is successful when an absolute value of a difference between the estimated distance and the focusing depth information is less than or equal to a fourth threshold.

[0030] With reference to any one of the fourth possible implementation manner of the third aspect to the sixth possible implementation manner of the third aspect, in a seventh possible implementation manner of the third aspect, the processor is further configured to: when the confidence of the M pieces of first depth information is less than or equal to the threshold or the check fails, control the first lens and the second lens of the second image shooting unit to move to new positions; and

at the new positions, a third image and a fourth image that are of the first object and collected at a same time by using the first image shooting unit and the second image shooting unit; and

the processor is further configured to: calculate P pieces of second depth information of N same feature point pairs in corresponding areas in the third image and the fourth image, where P is a positive integer; determine whether confidence of the P pieces of second depth information is greater than the threshold; obtain new focusing depth information according to L pieces of second depth information in the P pieces of second depth information when the confidence of the P pieces of second depth information is greater than the threshold, where L is a positive integer less than or equal to P; and obtain a new target position of the first lens according to the new focusing depth information, and control the first lens to move to the new target position.

[0031] With reference to the third aspect, any one of the first possible implementation manner of the third aspect to the third possible implementation manner of the third aspect, the fifth possible implementation manner of the third aspect, or the sixth possible implementation manner of the third aspect, in an eighth possible implementation manner of the third aspect, the processor is further configured to: when controlling the first lens to move to the target position, control a second lens of the second image shooting unit to move to a position corresponding to the target position.

[0032] One or more technical solutions provided in the embodiments of this application have at least the following technical effects or advantages:

[0033] In the embodiments of this application, at a same moment, a first image of a first object is collected by using a first image shooting unit, and a second image of the first object is collected by using a second image shooting unit; M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image are calculated; it is determined whether confidence of the M pieces of first depth information is greater than a threshold; focusing depth information is obtained according to N pieces of first depth information in the M pieces of first depth information when the confidence of the M pieces of first depth information is greater than the threshold; then, a target position of a first lens is obtained according to the focusing depth information; and the first lens is controlled to move to the target position. Therefore, in the embodiments, confidence of an object distance obtained in active focusing, that is, the M pieces of first depth information is determined. An active focusing method is used only when the confidence is greater than the threshold, that is, focusing depth information is obtained according to N pieces of first depth information in the M pieces of first depth information; then, the target position of the first lens is obtained according to the focusing depth information; and then the first lens is controlled to move to the target position to complete focusing. Therefore, in comparison with an active focusing method in the prior art, focusing precision is improved.

BRIEF DESCRIPTION OF DRAWINGS

[0034]

FIG. 1 is a flowchart of an auto-focus method according to an embodiment of this application;
FIG. 2 is a schematic disposing diagram of a lens of an image shooting unit according to an embodiment of this application;
FIG. 3 is an example diagram of an auto-focus method according to an embodiment of this application;
FIG. 4 is a functional block diagram of an auto-focus apparatus according to an embodiment of this application; and
FIG. 5 is a system block diagram of an electronic device according to an embodiment of this application.

DESCRIPTION OF EMBODIMENTS

[0035] Embodiments of this application provide an auto-focus method and apparatus, and an electronic device to improve focusing precision of active focusing.

[0036] To make the objectives, technical solutions, and advantages of the embodiments of this application clearer, the following clearly describes the technical solutions in the embodiments of this application with reference to the accompanying drawings in the embodiments of this application. Apparently, the described embodiments are merely some but not all of the embodiments of this application. All other embodiments obtained by persons of ordinary skill in the art based on the embodiments of this application without creative efforts shall fall within the protection scope of this application.

[0037] First, an implementation process of an auto-focus method in an embodiment of this application is described. Referring to FIG. 1, FIG. 1 is a flowchart of the auto-focus method in this embodiment, and the method includes the following content.

[0038] A step represented by number 101 is as follows: At a same moment, collect a first image of a first object by using a first image shooting unit, and collect a second image of the first object by using a second image shooting unit.

[0039] Optionally, parameters of the first image shooting unit and the second image shooting unit are the same. For example, the first image shooting unit and the second image shooting unit may also have a same focal length and same image sensors. Certainly, the first image shooting unit and the second image shooting unit may also have same lenses and another same hardware parameter.

[0040] It should be noted that, that the first image shooting unit and the second image shooting unit have one same parameter may be understood as that parameters of the first image shooting unit and the second image shooting unit are the same. Certainly, that the first image shooting unit and the second image shooting unit have multiple same parameters (for example, two or three same parameters) may also be understood as that parameters of the first image shooting unit and the second image shooting unit are the same. Preferably, all parameters of the first image shooting unit and the second image shooting unit are the same, that is, the first image shooting unit and the second image shooting unit are two same image shooting units.

[0041] The first image shooting unit and the second image shooting unit are disposed on an electronic device. For example, the electronic device is a mobile phone, a tablet computer, or a camera.

[0042] Optionally, a first lens of the first image shooting unit and a second lens of the second image shooting unit are disposed on a same side of the electronic device. Preferably, the first lens and the second lens are disposed on a same plane of the electronic device. For example, both of them are disposed on a rear cover of a mobile phone.

[0043] Optionally, the first lens may be a front-facing lens, and the second lens is a rear-facing lens. In use, one of the lenses may be flipped to a same side as the other lens.

[0044] Preferably, when an image is being obtained, an optical axis of the first image shooting unit is parallel to an optical axis of the second image shooting unit, to ensure that motion between the collected first image and second image is translation motion. In this way, a correction computation amount is small.

[0045] Referring to FIG. 2, FIG. 2 is a possible schematic diagram of a case in which a first image shooting unit 201 and a second image shooting unit 202 are disposed on an electronic device 20. The first image shooting unit 201 and the second image shooting unit 202 are disposed on a same side of the electronic device. For example, the first image shooting unit 201 and the second image shooting unit 202 are disposed on a rear cover side of the electronic device.

[0046] When the electronic device 20 is held in hand to take a photo, a first image is photographed by using the first image shooting unit 201, and a second image is photographed at a same time by using the second image shooting unit 202. Although the first image shooting unit

201 and the second image shooting unit 202 perform photographing on a same object, that is, a first object, a first collection area of the first image shooting unit 201 and a second collection area of the second image shooting unit 202 are not completely the same because there is a distance between an optical axis of the first image shooting unit 201 and that of the second image shooting unit 202 in a horizontal direction. However, there is an overlapped collection area between the first collection area and the second collection area.

[0047] Optionally, the electronic device that photographs the first image and the second image and an electronic device that performs steps represented by number 102 and number 103 may be a same electronic device. Specifically, the electronic device obtains image signals by using image sensors such as a charge-coupled device (English: Charge-coupled Device, CCD for short) or a complementary metal oxide semiconductor (English: Complementary Metal Oxide Semiconductor, CMOS for short) in the first image shooting unit and the second image shooting unit, and then transmits these image signals to an image signal processor (English: Image Signal Processor, ISP for short). The ISP preprocesses the image signals to obtain the first image and the second image.

[0048] Optionally, the electronic device that photographs the first image and the second image may not be a same electronic device as an electronic device that performs steps represented by number 102 and number 103. For example, the electronic device that photographs the first image and the second image is a mobile phone, a tablet computer, or a single-lens reflex camera, and a photographing process is described as above. The electronic device that performs the step represented by number 102 is a notebook computer, another mobile phone, or another tablet computer. In this case, after the first image and the second image are obtained by means of photographing, the first image and the second image are transmitted to the notebook computer, the another mobile phone, or the another tablet computer; and therefore, the notebook computer, the another mobile phone, or the another tablet computer obtains the first image and the second image.

[0049] In the following, a step represented by number 102 is described: Calculate M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image, where M is a positive integer and is less than or equal to a smaller total quantity of pixels in a total quantity of pixels in the first image and a total quantity of pixels in the second image. For example, if the total quantity of pixels in the first image is 600×1200 and the total quantity of pixels in the second image is 600×900, M is less than or equal to 600×900.

[0050] In this technical field, depth information indicates a distance between a photographed object and a lens. In this embodiment of this application, the M pieces of first depth information indicate distances separately between the first lens and M positions on the first object corresponding to the feature points.

[0051] In this technical field, a feature point is a pixel having a specific feature in an image, and an image feature has a color feature, a texture feature, a shape feature, and a spatial relationship feature. Feature points extracted according to different feature point extraction methods have different features. For example, a corner point (that is, a feature point) extracted by using a Harris (Harris) corner point extraction method is a point at which brightness of a two-dimensional image changes dramatically or a point that is corresponding to a maximum curvature value on an image edge curve. For another example, a feature point extracted by using a feature extraction method of scale-invariant feature transform (English: Scale-invariant feature transform, SIFT for short) is a feature vector that is irrelevant to scale zooming, rotation, and brightness variation. In this embodiment of this application, feature point extraction and calculating depth information of a feature point according to parallax between same feature points are content well known by persons skilled in the art. Therefore, details are not described herein again.

[0052] Optionally, the corresponding areas are areas corresponding to positions of focus windows when the first image and the second image are collected. It is assumed that an area in the first image is a first area, and an area in the second image is a second area. Because focusing needs to be performed, accuracy is relatively high and a calculation amount is small when a manner of calculating depth information of the positions of the focus windows is selected. Certainly, in practical application, the corresponding area may also be another area, or may even be an entire image area, which is not limited in this application.

[0053] Optionally, first feature points in the first area and second feature points in the second area may be extracted, and then depth information of the feature points, that is, the M pieces of first depth information, may be calculated according to parallax between same feature points in the first feature points and the second feature points.

[0054] After the M pieces of first depth information are calculated, a step represented by number 103 is performed subsequently: Determine whether confidence of the M pieces of first depth information is greater than a threshold.

[0055] The confidence represents reliability or precision of depth information.

[0056] In an embodiment, specifically, the determining whether confidence of the M pieces of first depth information is greater than a threshold may be implemented in the following manner: determining whether a quantity of first feature points is greater than or equal to a first threshold or determining whether a quantity of second feature points is greater than or equal to a second threshold, and when the quantity of first feature points is less than the first threshold and/or the quantity of second feature points is less than the second threshold, determining that the confidence of the M pieces of first depth information is less than or equal to the threshold. It is assumed that there are totally 100 pixels in the first area, but when a quantity of feature points extracted according to a specific feature point extraction method is less than the threshold (for example, the threshold is 30), for example, there are only two feature points, confidence of depth information calculated according to 50 feature points is greater than confidence of depth information calculated according to two feature points. Therefore, when the quantity of first feature points is less than the first threshold or the quantity of second feature points is less than the second threshold, confidence of depth information calculated according to the first feature points and the second feature points is relatively low.

[0057] Specifically, there are the following three cases. In the first case, it is determined whether the quantity of first feature points is greater than or equal to the first threshold; if the quantity of first feature points is less than the first threshold, it is determined that the confidence of the M pieces of first depth information is less than or equal to the threshold.

[0058] In the second case, it is determined whether the quantity of second feature points is greater than or equal to the second threshold; if the quantity of second feature points is less than the second threshold, it is determined that the confidence of the M pieces of first depth information is less than or equal to the threshold.

[0059] In the third case, it may be determined that the confidence of the M pieces of first depth information is less than or equal to the threshold provided that the quantity of first feature points is less than the first threshold or the quantity of second feature points is less than the second threshold.

[0060] Correspondingly, in the first case, when the quantity of first feature points is greater than the first threshold, it may be determined that the confidence of the M pieces of first depth information is greater than the threshold. Optionally, to further confirm that the confidence of the M pieces of first depth information is greater than the threshold, the method further includes: for the first feature points, searching the second feature points in a first sequence for first matching feature points that match the first feature points, and searching the second feature points in a second sequence for second matching feature points that match the first feature points, where the first sequence is reverse to the second sequence; determining a quantity of same matching feature points that are in the first matching feature points and the second matching feature points and that are corresponding to a same feature point in the first feature points, where each pair of same matching feature points is corresponding to a same feature point in the first feature points; and when a proportion of the quantity to the quantity of first feature points is less than a third threshold, determining that the confidence of the M pieces of first depth information is less than or equal to the threshold; or when a proportion of the quantity to the quantity of first feature points is greater than or equal to a third threshold, determining that the confidence of the M pieces of first depth information is greater than the threshold.

[0061] Specifically, the first sequence is a sequence from left to right, and the second sequence is a sequence from right to left. In practical application, the first sequence may also be a sequence from top to bottom, and the second sequence is a sequence from bottom to top.

[0062] For example, the first feature points are successively A, B, C, and D from left to right, and the second feature points are successively a, b, c, and d from left to right. For the first feature points, first, the second feature points are searched in a sequence from left to right for the first matching feature points that match the first feature points. It is assumed that a result of searching is that the second feature point b matches the first feature point B; the first matching feature point is the second feature point b. Then, the second feature points are searched in a sequence from right to left for the second matching feature points that match the first feature points. It is assumed that a result of searching is that the second feature point b matches the first feature point B, and the second feature point c matches the first feature point C; the second matching feature points are the second feature point b and the second feature point c. It may be seen that the first feature point B matches the second feature point b in both two times of searching, and therefore, the first feature point B is a feature point with high confidence, and is referred to as a first sub feature point. In other words, the quantity of same matching feature points in the first matching feature points and the second matching feature points is determined, where each pair of same matching feature points is corresponding to a same feature point in the first feature points. The quantity of same matching feature points is also a quantity of first sub feature points.

[0063] When the proportion of the quantity to the quantity of first feature points is less than the third threshold, it is determined that the confidence of the M pieces of first depth information is less than or equal to the threshold.

[0064] When the proportion of the quantity to the quantity of first feature points is greater than or equal to the third threshold, it is determined that the confidence of the M pieces of first depth information is greater than the threshold.

[0065] In other words, in this embodiment of this application, when feature point matching can succeed in both of two directions and a quantity of feature point pairs that match successfully is larger, it means that there are more reliable feature points, and confidence of depth information calculated by using the feature points is higher. If a quantity of feature pairs that match successfully in both of the two directions is smaller, it means that there are fewer reliable feature points, and confidence of depth information calculated by using the feature points is lower.

[0066] Corresponding to the foregoing second case, when the quantity of second feature points is greater than the first threshold, it may be determined that the confidence of the M pieces of first depth information is greater than the threshold. Optionally, to further confirm that the confidence of the M pieces of first depth information is greater than the threshold, steps same as the foregoing may be performed.

[0067] Corresponding to the foregoing third case, when the quantity of first feature points is greater than or equal to the first threshold and when the quantity of second feature points is greater than or equal to the second threshold, the foregoing described step of further confirming that the confidence of the M pieces of first depth information is greater than the threshold is performed.

[0068] When it is determined, by using the foregoing methods, that the confidence of the M pieces of first depth information is greater than the threshold, a step represented by number 104 is performed subsequently: Obtain focusing depth information according to N pieces of first depth information in the M pieces of first depth information, where N is a positive integer less than or equal to M.

[0069] In an embodiment, the obtaining focusing depth information according to N pieces of first depth information in the M pieces of first depth information may have multiple implementation manners. Specifically, in the first implementation manner, a weighted average value of the M pieces of first depth information is used as the focusing depth information. In the second implementation manner, depth information that is significantly different from other depth information may be first excluded from the M pieces of first depth information, and then a weighted average value of remaining first depth information is calculated and used as the focusing depth information. In the third implementation manner, one piece of first depth information is selected from the M pieces of first depth information as the focusing depth information. In the fourth implementation manner, multiple pieces of first depth information are randomly selected from the M pieces of first depth information, and then weighted average calculation is performed to obtain the focusing depth information.

[0070] In another embodiment, when the foregoing described method of further confirming whether the confidence of the M pieces of first depth information is greater than the threshold is implemented, the obtaining focusing depth information according to N pieces of first depth information in the M pieces of first depth information includes: obtaining the focusing depth information according to depth information corresponding to the same feature point, that is, the first sub feature point. Specifically, in an embodiment, the focusing depth information is a weighted average value of depth information of all first sub feature points. In another embodiment, a first sub feature point of which depth information is significantly different from a majority of depth information is first excluded, and a weighted average of depth information of remaining first sub feature points is calculated and used as the final focusing depth information. Because the first sub feature point is a feature point with high confidence obtained by means of screening by using the foregoing method, accuracy of the focusing depth information calculated according to the depth information corresponding to the first sub feature point is higher.

[0071] A step represented by number 105 is performed subsequently: Obtain a target position of a first lens according to the focusing depth information, and control the first lens to move to the target position. Specifically, the obtaining a target position of a first lens according to the focusing depth information may also have multiple implementation manners. For example, if a correspondence between an object distance and a position of the first lens is stored in an electronic device, the target position corresponding to the focusing depth information may be obtained by querying the correspondence. For another example, obtaining the focusing depth information is equivalent to obtaining an object distance, and therefore, a focal length may be calculated according to the object distance, and further the target position may be obtained.

[0072] Optionally, the controlling the first lens to move to the target position may be controlling movement of the first lens by controlling a first actuator, for example, a voice coil motor (English: Voice Coil Motor, VCM for short). Specifically, the voice coil motor includes a coil, a magnet set, and a spring plate. The coil is fixed in the magnet set by using two spring plates: an upper spring plate and a lower spring plate. When the coil is powered on, the coil generates a magnetic field. The magnetic field of the coil interacts with the magnet set, the coil moves upward, and the first lens locked in the coil moves together. When the coil is powered off, the coil returns back to an original position under an elastic force of the spring plate.

[0073] Certainly, in practical application, specifically, the first lens may further be drove, by controlling another actuator such as a motor in another form or an associated component, to move to the target position.

[0074] The step represented by number 105 is similar to active focusing, that is, when the confidence of the M pieces of first depth information is greater than the threshold, the active focusing may be used, which improves focusing precision in a case of ensuring a focusing speed.

[0075] Optionally, when the first lens is controlled to move to the target position, the method further includes: controlling a second lens of the second image shooting unit to move to a position corresponding to the target position.

[0076] Specifically, the position to which the second lens needs to move may also be specifically determined in multiple manners. In the first manner, for example, a correspondence between the object distance and a position of the second lens may further be included in the correspondence of the object distance and the position of the first lens; the position to which the second lens needs to move may be obtained by querying the correspondence. In this embodiment, the positions to which the first lens and the second lens need to move may be determined by using the target position or the focusing depth information.

[0077] In the second manner, the second lens may also be moved to a corresponding position by using steps similar to the steps represented by number 102 to number 105. In this embodiment, processing is separately performed for the two lenses, and processing methods are the same.

[0078] Optionally, further, after the first lens moves to the target position, a user may press a shutter to shoot an image. Because focusing is performed, definition of an image area corresponding to the focus window is higher than that of another area. For the second image shooting unit, a principle is the same. After the second lens moves to the position corresponding to the target position, a focused image may also be obtained.

[0079] Optionally, after the focusing depth information is obtained, a check may further be performed on the focusing depth information. Image shooting is performed at the target position only after the check succeeds. Steps of the check specifically include: controlling the second lens of the second image shooting unit to move to a third position; and determining that the check on the focusing depth information succeeds when a first contrast that is of an image obtained before the first lens moves to the target position and that is in a focus window area is less than a second contrast that is of an image obtained when the first lens is at the target position and that is in a focus window area, and a third contrast that is of an image obtained when the second lens is at the third position and that is in a focus window area is less than the second contrast.

[0080] An image contrast refers to an image color difference. In practical application, there are different calculation methods, for example, measurement of different brightness levels between the brightest white area and the darkest black area in an image in a focus window area, a larger difference range represents a larger contrast, and a smaller difference range represents a smaller contrast. Contrast calculation is content well known by persons skilled in the art. Therefore, details are not described herein again.

[0081] For example, it is assumed that a position of the first lens before the first lens moves to the target position is P0, and the target position is PI. It is assumed that the third position is P2, and in an embodiment, P2=(P0+P1)/2. It is assumed that at the position P0, a contrast that is of an image obtained by the first image shooting unit and is in the focus window area is a first contrast C(P0). A contrast that is of an image obtained at the position PI by the first image shooting unit and is in the focus window area is a second contrast C(P1). A contrast that is of an image obtained at the position P2 by the second image shooting unit and is in the focus window area is a third contrast C(P2). When C(P2)<C(P1) and C(P0)<C(P1), it is determined that the check on the focusing depth information succeeds. When C(P2) is greater than or equal to C(P1), or C(P0) is greater than or equal to C(P1), it is determined that the check on the focusing depth information fails.

[0082] Optionally, before the first lens is controlled to move to the target position, it may be determined that the check on the focusing depth information is successful. In this embodiment, steps of the check on the focusing depth information include: calculating an estimated size of the first object according to a size of the first object in the first image; comparing the estimated size obtained through calculation with prior data, where if an absolute value of a difference between the estimated size and the prior data is greater than a set threshold, it indicates that the check on the focusing depth information fails, and otherwise, the check succeeds. The estimated size of the first object is calculated according to the size of the first object in the first image, and may be specifically calculated in this way: Because the size of the first object in the first image, a distance between the image sensor and the first lens, and the M pieces of first depth information are all known, the estimated size of the first object may be obtained through calculation according to an imaging principle and a similar triangle principle. For example, it is assumed that a width of a car is 3 meters, but an estimated size of the car calculated according to a size of the car in the first image is much greater than 3 meters, it means that calculation of the M pieces of first depth information is wrong, and it indicates that the check fails, and otherwise, the check succeeds.

[0083] In a scenario of photographing a person, when a human face is detected in the focus window, in addition to the foregoing check methods, the check may further be performed on the focusing depth information by using the following steps: estimating an estimated distance between the human face and the first lens according to a size of a human face frame; and determining that the check on the focusing depth information is successful when an absolute value of a difference between the estimated distance and the focusing depth information is less than or equal to a fourth threshold. Otherwise, the check on the focusing depth information fails. The human face frame is used to represent a position of the human face.

[0084] The estimating an estimated distance between the human face and the first lens according to a size of a human face frame is specifically as follows: A quantity of pixels corresponding to the human face frame, that is, a size in the first image, is in a specific proportion to a distance between the human face and the first lens, and then the estimated distance between the human face and the first lens may be estimated according to the proportion and the size of the human face frame. Then, when an absolute value of a difference between the focusing depth information and the estimated distance estimated by using this method is less than or equal to the fourth threshold, it means that the check succeeds, and otherwise, the check fails.

[0085] Optionally, when the check succeeds, distance measurement method focusing is enabled according to the focusing depth information to directly move the lens to a position of a corresponding depth.

[0086] Optionally, regardless of using which of the foregoing check methods or another check method, when the check fails, or it is determined that the confidence of the M pieces of first depth information is less than or equal to the threshold, the method further includes: controlling the first lens and the second lens of the second image shooting unit to move to new positions; at the new positions, collecting, at a same time, a third image and a fourth image that are of the first object respectively by using the first image shooting unit and the second image shooting unit; calculating P pieces of second depth information of P same feature point pairs in corresponding areas in the third image and the fourth image; determining whether confidence of the P pieces of second depth information is greater than the threshold; obtaining new focusing depth information according to L second depth information in the P pieces of second depth information when the confidence of the P pieces of second depth information is greater than the threshold; and obtaining a new target position of the first lens according to the new focusing depth information, and controlling the first lens to move to the new target position, where P is a positive integer, and L is a positive integer less than or equal to M. Certainly, P is less than or equal to a smaller total quantity of pixels in a total quantity of pixels in the third image and a total quantity of pixels in the fourth image.

[0087] Optionally, the first lens and the second lens are moved to the new positions and may be moved in a fixed step length manner, that is, moving amplitude each time is the same. A manner of gradually increasing or gradually decreasing a moving step length may also be used to move the lenses. In practical application, moving may further be performed according to another rule, which is not limited in this application.

[0088] An implementation process of remaining steps is similar to that of the foregoing steps represented in FIG. 1, and details are not described herein again.

[0089] In this embodiment, it is equivalent to that after a lens is moved each time in passive focusing, depth information is recalculated, and then confidence of the depth information is determined, where when the confidence is high, a manner similar to active focusing is used or a check is performed on the distance. If the confidence is low or the checking fails, the lens is moved again, depth information is recalculated again, and then confidence of the depth information is determined again. This cycle is repeated in this way. Both a speed of active focusing and precision of passive focusing may be ensured by using the method in this embodiment.

[0090] The following describes a specific example of an auto-focus method, and reference may be made to FIG. 3.

[0091] First, a first image and a second image are obtained, and specifically, position information of focus windows when the first image and the second image are photographed is further obtained. Then, M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image are calculated. Specifically, depth information of same feature points in focus window areas may be calculated and used as the M pieces of first depth information. Then, it is determined whether confidence of the M pieces of first depth information is greater than a threshold. If no, passive focusing is enabled. If yes, focusing depth information is obtained according to N pieces of first depth information in the M pieces of first depth information, and a check is performed on the focusing depth information. Then, it is determined whether the check succeeds. If the check fails, the passive focusing is also enabled. If the check succeeds, active focusing is enabled. Optionally, after the passive focusing is enabled, and a lens is moved to a new position, go back and continue to perform a step of calculating the M pieces of first depth information, and then continue to perform steps subsequently in a sequence of the flowchart. This cycle is repeated in this way until focusing succeeds.

[0092] Based on a same inventive concept, an embodiment of this application further provides an auto-focus apparatus. Referring to FIG. 4, FIG. 4 is a functional block diagram of the auto-focus apparatus. A term involved in this embodiment is the same as or similar to the foregoing term. The apparatus includes: an acquiring unit 301, configured to obtain a first image that is of a first object and collected by using a first image shooting unit, and a second image that is of the first object and collected by using a second image shooting unit, where the first image and the second image are collected at a same moment; and a processing unit 302, configured to: calculate M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image, where M is a positive integer; determine whether confidence of the M pieces of first depth information is greater than a threshold; obtain focusing depth information according to N pieces of first depth information in the M pieces of first depth information when the confidence of the M pieces of first depth information is greater than the threshold, where N is a positive integer less than or equal to M; and obtain a target position of a first lens of the first image shooting unit according to the focusing depth information, and control the first lens to move to the target position.

[0093] Optionally, the corresponding areas are areas corresponding to positions of focus windows when the first image and the second image are collected, an area in the first image is a first area, an area in the second image is a second area, and the processing unit 302 is specifically configured to: determine whether a quantity of first feature points in the first area is greater than or equal to a first threshold or determine whether a quantity of second feature points in the second area is greater than or equal to a second threshold, and when the quantity of first feature points is less than the first threshold and/or the quantity of second feature points is less than the second threshold, determine that the confidence of the M pieces of first depth information is less than or equal to the threshold.

[0094] Further, the processing unit 302 is further configured to: when the quantity of first feature points is greater than or equal to the first threshold and the quantity of second feature points is greater than or equal to the second threshold, for the first feature points, search the second feature points in a first sequence for first matching feature points that match the first feature points, and search the second feature points in a second sequence for second matching feature points that match the first feature points, where the second sequence is reverse to the first sequence;

determine a quantity of same matching feature points that are in the first matching feature points and the second matching feature points and that are corresponding to a same feature point in the first feature points; and

when a proportion of the quantity to the quantity of first feature points is less than a third threshold, determine that the confidence of the M pieces of first depth information is less than or equal to the threshold; or

when a proportion of the quantity to the quantity of first feature points is greater than or equal to a third threshold, determine that the confidence of the M pieces of first depth information is greater than the threshold.

[0095] Further, the processing unit 302 is specifically configured to obtain the focusing depth information according to depth information corresponding to the same feature point.

[0096] With reference to the foregoing embodiments, the processing unit 302 is further configured to: after controlling the first lens to move to the target position, control a second lens of the second image shooting unit to move to a third position; determine that a check on the focusing depth information succeeds when a first contrast that is of an image obtained before the first lens moves to the target position and that is in a focus window area is less than a second contrast that is of an image obtained when the first lens is at the target position and that is in a focus window area, and a third contrast that is of an image obtained when the second lens is at the third position and that is in a focus window area is less than the second contrast; and control performing image shooting at the target position.

[0097] With reference to the foregoing embodiments, the processing unit 302 is further configured to: before controlling the first lens to move to the target position, determine that a check on the focusing depth information is successful.

[0098] Further, the processing unit 302 is specifically configured to: when a human face is detected in the focus window, estimate an estimated distance between the human face and the first lens according to a size of a human face frame; and determine that the check on the focusing depth information is successful when an absolute value of a difference between the estimated distance and the focusing depth information is less than or equal to a fourth threshold.

[0099] With reference to the foregoing embodiments, the processing unit 302 is further configured to: when the confidence of the M pieces of first depth information is less than or equal to the threshold or the check fails, control the first lens and the second lens of the second image shooting unit to move to new positions.

[0100] The acquiring unit 301 is further configured to obtain, at the new positions, a third image and a fourth image that are of the first object and collected at a same time respectively by using the first image shooting unit and the second image shooting unit.

[0101] The processing unit 302 is further configured to: calculate P pieces of second depth information of N same feature point pairs in corresponding areas in the third image and the fourth image, where P is a positive integer; determine whether confidence of the P pieces of second depth information is greater than the threshold; obtain new focusing depth information according to L pieces of second depth information in the P pieces of second depth information when the confidence of the P pieces of second depth information is greater than the threshold, where L is a positive integer less than or equal to P; and obtain a new target position of the first lens according to the new focusing depth information, and control the first lens to move to the new target position.

[0102] With reference to the foregoing embodiments, the processing unit 302 is further configured to: when controlling the first lens to move to the target position, control a second lens of the second image shooting unit to move to a position corresponding to the target position.

[0103] Various types of variations and specific examples in the auto-focus method in the foregoing embodiments in FIG. 1 to FIG. 3 are also applicable to the auto-focus apparatus in this embodiment. With the detailed description of the foregoing auto-focus method, persons skilled in the art may clearly understand an implementation method of the auto-focus apparatus in this embodiment. Therefore, for conciseness of the specification, details are not described herein again.

[0104] Based on a same inventive concept, an embodiment of this application further provides an electronic device. Referring to FIG. 5, FIG. 5 is a system block diagram of the electronic device in this embodiment. A term involved in this embodiment is the same as or similar to the foregoing term. The electronic device includes: a first image shooting unit 401 and a second image shooting unit 402, configured to respectively collect, at a same moment, a first image and a second image that are of a first object; a first actuator 403; and a processor 404, configured to: calculate M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image, where M is a positive integer; determine whether confidence of the M pieces of first depth information is greater than a threshold; obtain focusing depth information according to N pieces of first depth information in the M pieces of first depth information when the confidence of the M pieces of first depth information is greater than the threshold, where N is a positive integer less than or equal to M; and obtain a target position of a first lens of the first image shooting unit 401 according to the focusing depth information, and control the first actuator 403 to move, so that the first lens moves to the target position.

[0105] Specifically, the first image shooting unit 401 includes the first lens and a first image sensor. The first image sensor is, for example, a charge-coupled device (English: Charge-coupled Device, CCD for short) or a complementary metal oxide semiconductor (English: Complementary Metal Oxide Semiconductor, CMOS for short). The second image shooting unit 402 includes a second lens and a second image sensor.

[0106] Optionally, the first actuator 403 is a voice coil motor.

[0107] Optionally, the corresponding areas are areas corresponding to positions of focus windows when the first image and the second image are collected, an area in the first image is a first area, an area in the second image is a second area, and the processor 404 is specifically configured to: determine whether a quantity of first feature points in the first area is greater than or equal to a first threshold or determine whether a quantity of second feature points in the second area is greater than or equal to a second threshold, and when the quantity of first feature points is less than the first threshold and/or the quantity of second feature points is less than the second threshold, determine that the confidence of the M pieces of first depth information is less than or equal to the threshold.

[0108] Further, the processor 404 is further configured to: when the quantity of first feature points is greater than or equal to the first threshold and the quantity of second feature points is greater than or equal to the second threshold, for the first feature points, search the second feature points in a first sequence for first matching feature points that match the first feature points, and search the second feature points in a second sequence for second matching feature points that match the first feature points, where the second sequence is reverse to the first sequence;

determine a quantity of same matching feature points that are in the first matching feature points and the second matching feature points and that are corresponding to a same feature point in the first feature points; and

when a proportion of the quantity to the quantity of first feature points is less than a third threshold, determine that the confidence of the M pieces of first depth information is less than or equal to the threshold; or

when a proportion of the quantity to the quantity of first feature points is greater than or equal to a third threshold, determine that the confidence of the M pieces of first depth information is greater than the threshold.

[0109] Further, the processor 404 is specifically configured to obtain the focusing depth information according to depth information corresponding to the same feature point.

[0110] With reference to the foregoing embodiments, the electronic device further includes a second actuator 405, and the processor 404 is further configured to: after controlling the first lens to move to the target position, control the second actuator 405 to move, so as to move the second lens of the second image shooting unit 402 to a third position; determine that a check on the focusing depth information succeeds when a first contrast that is of an image obtained before the first lens moves to the target position and that is in a focus window area is less than a second contrast that is of an image obtained when the first lens is at the target position and that is in a focus window area, and a third contrast that is of an image obtained when the second lens is at the third position and that is in a focus window area is less than the second contrast; and control performing image shooting at the target position.

[0111] Optionally, the second actuator 405 may be the same as or may be different from the first actuator 405.

[0112] With reference to the foregoing embodiments, the processor 404 is further configured to: before controlling the first lens to move to the target position, determine that a check on the focusing depth information is successful.

[0113] Further, the processor 404 is specifically configured to: when a human face is detected in the focus window, estimate an estimated distance between the human face and the first lens according to a size of a human face frame; and determine that the check on the focusing depth information is successful when an absolute value of a difference between the estimated distance and the focusing depth information is less than or equal to a fourth threshold.

[0114] With reference to the foregoing embodiments, the processor 404 is further configured to: when the confidence of the M pieces of first depth information is less than or equal to the threshold or the check fails, control the first lens and the second lens of the second image shooting unit 402 to move to new positions; and

at the new positions, a third image and a fourth image that are of the first object and collected at a same time by using the first image shooting unit 401 and the second image shooting unit 402.

[0115] The processor 404 is further configured to: calculate P pieces of second depth information of N same feature point pairs in corresponding areas in the third image and the fourth image, where P is a positive integer; determine whether confidence of the P pieces of second depth information is greater than the threshold; obtain new focusing depth information according to L pieces of second depth information in the P pieces of second depth information when the confidence of the P pieces of second depth information is greater than the threshold, where L is a positive integer less than or equal to P; and obtain a new target position of the first lens according to the new focusing depth information, and control the first lens to move to the new target position.

[0116] With reference to the foregoing embodiments, the processor 404 is further configured to: when controlling the first lens to move to the target position, control a second lens of the second image shooting unit 402 to move to a position corresponding to the target position.

[0117] Continuing to refer to FIG. 5, the electronic device further includes a display 406, configured to display an image/images obtained by the first image shooting unit 401 and/or the second image shooting unit 402 or the processor 404.

[0118] Optionally, the electronic device further includes a memory 407, configured to store data that is used when the processor 404 performs an operation or temporary image data obtained by the first image shooting unit 401 and/or the second image shooting unit 402.

[0119] Optionally, the processor 404 may specifically include a central processing unit 404 (CPU) and an IPS.

[0120] Optionally, the processor 404 is a CPU and is a chip that is mutually independent of an IPS physically.

[0121] Optionally, the electronic device further includes a battery, configured to supply power to the electronic device.

[0122] Various types of variations and specific examples in the auto-focus method in the foregoing embodiments in FIG. 1 to FIG. 3 are also applicable to the electronic device in this embodiment. With the detailed description of the foregoing auto-focus method, persons skilled in the art may clearly understand an implementation method of the electronic device in this embodiment. Therefore, for conciseness of the specification, details are not described herein again.

[0123] One or more technical solutions provided in the embodiments of this application have at least the following technical effects or advantages:

[0124] In the embodiments of this application, at a same moment, a first image of a first object is collected by using a first image shooting unit, and a second image of the first object is collected by using a second image shooting unit; M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image are calculated; it is determined whether confidence of the M pieces of first depth information is greater than a threshold; when the confidence of the M pieces of first depth information is greater than the threshold, a target position of a first lens is calculated according to the M pieces of first depth information, and the first lens is controlled to move to the target position. Therefore, in the embodiments, confidence of an object distance obtained in active focusing, that is, the M pieces of first depth information is determined. An active focusing method is used only when the confidence is greater than the threshold, that is, the target position of the first lens is obtained according to N pieces of first depth information in the M pieces of first depth information, and then the first lens is controlled to move to a current position to complete focusing. Therefore, in comparison with an active focusing method in the prior art, focusing precision is improved.

[0125] Persons skilled in the art should understand that the embodiments of this application may be provided as method and device embodiments and may be implemented in a hardware or combination of software and hardware manner.

[0126] This application is described with reference to the flowcharts or block diagrams of the method, the device (system), and the computer program product according to the embodiments of this application. It should be understood that computer program instructions may be used to implement each process or each block in the flowcharts or the block diagrams and a combination of a process or a block in the flowcharts or the block diagrams. These computer program instructions may be provided for a general-purpose computer, a dedicated computer, an embedded processor, or a processor of any other programmable data processing device to generate a machine, so that the instructions executed by a computer or a processor of any other programmable data processing device generate an apparatus for implementing a specific function in one or more processes in the flowcharts or in one or more blocks in the block diagrams.

[0127] These computer program instructions may be stored in a computer-readable memory that can instruct the computer or any other programmable data processing device, so that the instructions stored in the computer-readable memory generate an artifact that includes an instruction apparatus. The instruction apparatus implements a specific function in one or more processes in the flowcharts or in one or more blocks in the block diagrams.

[0128] These computer program instructions may also be loaded onto a computer or another programmable data processing device, so that a series of operations and steps are performed on the computer or the another programmable device, thereby generating computer-implemented processing. Therefore, the instructions executed on the computer or the another programmable device provide steps for implementing a specific function in one or more processes in the flowcharts or in one or more blocks in the block diagrams.

[0129] Obviously, persons skilled in the art can make various modifications and variations to this application without departing from the scope of this application. This application is intended to cover these modifications and variations provided that they fall within the scope of protection defined by the following claims.

Claims

1. An auto-focus method, comprising:

   at a same moment, collecting (101) a first image of a first object by using a first image shooting unit (201, 401), and collecting a second image of the first object by using a second image shoot-

ing unit (202, 402); and
obtaining (105) a target position of a first lens of the first image shooting unit according to focusing depth information, and controlling the first lens to move to the target position
characterized in that the method further comprises:

calculating (102) M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image, wherein M is a positive integer;
determining (103) whether confidence of the M pieces of first depth information is greater than a threshold; and
obtaining (104) focusing depth information according to N pieces of first depth information in the M pieces of first depth information when the confidence of the M pieces of first depth information is greater than the threshold, wherein N is a positive integer less than or equal to M.

2. The method according to claim 1, wherein the corresponding areas are areas corresponding to positions of focus windows when the first image and the second image are collected, an area in the first image is a first area, an area in the second image is a second area, and the determining whether confidence of the M pieces of first depth information is greater than a threshold comprises:

determining whether a quantity of first feature points in the first area is greater than or equal to a first threshold or determining whether a quantity of second feature points in the second area is greater than or equal to a second threshold, and when the quantity of first feature points is less than the first threshold and/or the quantity of second feature points is less than the second threshold,
determining that the confidence of the M pieces of first depth information is less than or equal to the threshold.

3. The method according to any one of claims 1-2, wherein when the quantity of first feature points is greater than or equal to the first threshold and the quantity of second feature points is greater than or equal to the second threshold, the method further comprises:

for the first feature points, searching the second feature points in a first sequence for first matching feature points that match the first feature points, and searching the second feature points in a second sequence for second matching feature points that match the first feature points, wherein the second sequence is reverse to the first sequence;
determining a quantity of same matching feature points that are in the first matching feature points and the second matching feature points and that are corresponding to a same feature point in the first feature points; and
when a proportion of the quantity to the quantity of first feature points is less than a third threshold, determining that the confidence of the M pieces of first depth information is less than or equal to the threshold; or
when a proportion of the quantity to the quantity of first feature points is greater than or equal to a third threshold, determining that the confidence of the M pieces of first depth information is greater than the threshold.

4. The method according to any one of claims 1-3, wherein the obtaining focusing depth information according to N pieces of first depth information in the M pieces of first depth information comprises:
obtaining the focusing depth information according to depth information corresponding to the same feature point.

5. The method according to any one of claims 1-4, wherein after the controlling the first lens to move to the target position, the method further comprises:

controlling a second lens of the second image shooting unit (202, 402) to move to a third position;
determining that a check on the focusing depth information succeeds when a first contrast that is of an image obtained before the first lens moves to the target position and that is in a focus window area is less than a second contrast that is of an image obtained when the first lens is at the target position and that is in a focus window area, and a third contrast that is of an image obtained when the second lens is at the third position and that is in a focus window area is less than the second contrast; and
performing image shooting at the target position.

6. The method according to any one of claims 1-5, wherein before the controlling the first lens to move to the target position, the method further comprises:
determining that a check on the focusing depth information is successful.

7. The method according to any one of claims 1-6, wherein when a human face is detected in the focus window, the check is performed on the focusing depth information by using the following steps:

estimating an estimated distance between the human face and the first lens according to a size of a human face frame; and
determining that the check on the focusing depth information is successful when an absolute value of a difference between the estimated distance and the focusing depth information is less than or equal to a fourth threshold.

8. An electronic device, comprising:

a first image shooting unit (201, 401) and a second image shooting unit (202, 402), configured to respectively collect, at a same moment, a first image and a second image that are of a first object;
a first actuator; and
a processor (404), configured to control the first actuator to move, so that the first lens moves to a target position,
characterized in that the processor is further configured to:

calculate M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image, wherein M is a positive integer; determine whether confidence of the M pieces of first depth information is greater than a threshold;
obtain focusing depth information according to N pieces of first depth information in the M pieces of first depth information when the confidence of the M pieces of first depth information is greater than the threshold, wherein N is a positive integer less than or equal to M; and
obtain the target position of a first lens of the first image shooting unit (201, 401) according to the focusing depth information.

9. The electronic device according to claim 8, wherein the corresponding areas are areas corresponding to positions of focus windows when the first image and the second image are collected, an area in the first image is a first area, an area in the second image is a second area, and the processor is specifically configured to: determine whether a quantity of first feature points in the first area is greater than or equal to a first threshold or determine whether a quantity of second feature points in the second area is greater than or equal to a second threshold, and when the quantity of first feature points is less than the first threshold and/or the quantity of second feature points is less than the second threshold, determine that the confidence of the M pieces of first depth information is less than or equal to the threshold.

10. The electronic device according to any one of claims 8-9, wherein the processor is further configured to: when the quantity of first feature points is greater than or equal to the first threshold and the quantity of second feature points is greater than or equal to the second threshold, for the first feature points, search the second feature points in a first sequence for first matching feature points that match the first feature points, and search the second feature points in a second sequence for second matching feature points that match the first feature points, wherein the second sequence is reverse to the first sequence;
determine a quantity of same matching feature points that are in the first matching feature points and the second matching feature points and that are corresponding to a same feature point in the first feature points; and
when a proportion of the quantity to the quantity of first feature points is less than a third threshold, determine that the confidence of the M pieces of first depth information is less than or equal to the threshold; or
when a proportion of the quantity to the quantity of first feature points is greater than or equal to a third threshold, determine that the confidence of the M pieces of first depth information is greater than the threshold.

11. The electronic device according to any one of claims 8-10, wherein the processor is specifically configured to obtain the focusing depth information according to depth information corresponding to the same feature point.

12. The electronic device according to any one of claims 8-11, wherein the electronic device further comprises a second actuator, and the processor is further configured to: after controlling the first lens to move to the target position, control the second actuator to move, so as to move a second lens of the second image shooting unit (202, 402) to a third position; determine that a check on the focusing depth information succeeds when a first contrast that is of an image obtained before the first lens moves to the target position and that is in a focus window area is less than a second contrast that is of an image obtained when the first lens is at the target position and that is in a focus window area, and a third contrast that is of an image obtained when the second lens is at the third position and that is in a focus window area is less than the second contrast; and control performing image shooting at the target position.

13. The electronic device according to any one of claims 8-12, wherein the processor is further configured to: before controlling the first lens to move to the target position, determine that a check on the focusing depth information is successful.

14. The electronic device according to any one of claims 8-13, wherein the processor is specifically configured to: when a human face is detected in the focus window, estimate an estimated distance between the human face and the first lens according to a size of a human face frame; and determine that the check on the focusing depth information is successful when an absolute value of a difference between the estimated distance and the focusing depth information is less than or equal to a fourth threshold.

Patentansprüche

1. Autofokusverfahren, umfassend:

zu einem gleichen Zeitpunkt, Erfassen (101) eines ersten Bilds eines ersten Gegenstands mithilfe einer ersten Bildaufnahmeeinheit (201, 401), und Erfassen eines zweiten Bilds des ersten Gegenstands mithilfe einer zweiten Bildaufnahmeeinheit (202, 402); und
Erhalten (105) einer Zielposition einer ersten Linse der ersten Bildaufnahmeeinheit gemäß Fokussierungstiefeninformationen, und Steuern der ersten Linse, um sie zu der Zielposition zu bewegen;
dadurch gekennzeichnet, dass das Verfahren ferner umfasst:

Berechnen (102) von M ersten Tiefeninformationselementen von M gleichen Merkmalspunktpaaren in entsprechenden Bereichen in dem ersten Bild und dem zweiten Bild, wobei M eine positive Ganzzahl ist;
Bestimmen (103), ob die Konfidenz der M ersten Tiefeninformationselemente größer als ein Schwellenwert ist; und
Erhalten (104) von Fokussierungstiefeninformationen gemäß N ersten Tiefeninformationselementen in den M ersten Tiefeninformationselementen, wenn die Konfidenz der M ersten Tiefeninformationselemente größer als der Schwellenwert ist, wobei N eine positive Ganzzahl kleiner als oder gleich M ist.

2. Verfahren nach Anspruch 1, wobei die entsprechenden Bereiche Bereiche sind, die Positionen von Fokusfenstern entsprechen, wenn das erste Bild und das zweite Bild erfasst werden, wobei ein Bereich in dem ersten Bild ein erster Bereich ist, ein Bereich in dem zweiten Bild ein zweiter Bereich ist und das Bestimmen, ob die Konfidenz der M ersten Tiefeninformationselemente größer als ein Schwellenwert ist, umfasst: Bestimmen, ob eine Menge an ersten Merkmalspunkten in dem ersten Bereich größer als oder gleich einem ersten Schwellenwert ist, oder Bestimmen, ob eine Menge an zweiten Merkmalspunkten in dem zweiten Bereich größer als oder gleich einem zweiten Schwellenwert ist, und wenn die Menge an ersten Merkmalspunkten kleiner als der erste Schwellenwert ist und/oder die Menge an zweiten Merkmalspunkten kleiner als der zweite Schwellenwert ist, Bestimmen, dass die Konfidenz der M ersten Tiefeninformationselemente kleiner als oder gleich dem Schwellenwert ist.

3. Verfahren nach einem der Ansprüche 1 bis 2, wobei, wenn die Menge an ersten Merkmalspunkten größer als oder gleich dem ersten Schwellenwert ist und die Menge an zweiten Merkmalspunkten größer als oder gleich dem zweiten Schwellenwert ist, das Verfahren ferner umfasst:

für die ersten Merkmalspunkte Absuchen der zweiten Merkmalspunkte in einer ersten Sequenz nach ersten übereinstimmenden Merkmalspunkten, die mit den ersten Merkmalspunkten übereinstimmen, und Absuchen der zweiten Merkmalspunkte in einer zweiten Sequenz nach zweiten übereinstimmenden Merkmalspunkten, die mit den ersten Merkmalspunkten übereinstimmen, wobei die zweite Sequenz umgekehrt zu der ersten Sequenz ist;
Bestimmen einer Menge an gleichen übereinstimmenden Merkmalspunkten, die sich in den ersten übereinstimmenden Merkmalspunkten und den zweiten übereinstimmenden Merkmalspunkten befinden und die einem gleichen Merkmalspunkt in den ersten Merkmalspunkten entsprechen; und
wenn ein Verhältnis der Menge zur Menge an ersten Merkmalspunkten kleiner als ein dritter Schwellenwert ist, Bestimmen, dass die Konfidenz der M ersten Tiefeninformationselemente kleiner als oder gleich dem Schwellenwert ist; oder
wenn ein Verhältnis der Menge zur Menge an ersten Merkmalspunkten größer als oder gleich einem dritten Schwellenwert ist, Bestimmen, dass die Konfidenz der M ersten Tiefeninformationselemente größer als der Schwellenwert ist.

4. Verfahren nach einem der Ansprüche 1 bis 3, wobei das Erhalten von Fokussierungstiefeninformationen gemäß N ersten Tiefeninformationselementen in den M ersten Tiefeninformationselementen umfasst: Erhalten der Fokussierungstiefeninformationen gemäß Tiefeninformationen, die dem gleichen Merkmalspunkt entsprechen.

5. Verfahren nach einem der Ansprüche 1 bis 4, wobei nach dem Steuern der ersten Linse, um sie zu der Zielposition zu bewegen, das Verfahren ferner umfasst:

Steuern einer zweiten Linse der zweiten Bildaufnahmeeinheit (202, 402), um sie zu einer dritten Position zu bewegen;

Bestimmen, dass eine Prüfung der Fokussierungstiefeninformationen Erfolg hat, wenn ein erster Kontrast, der jener eines Bilds ist, das erhalten wird, bevor sich die erste Linse zu der Zielposition bewegt, und der in einem Fokusfensterbereich ist, kleiner als ein zweiter Kontrast ist, der jener eines Bilds ist, das erhalten wird, wenn die erste Linse in der Zielposition ist und der in einem Fokusfensterbereich ist, und ein dritter Kontrast, der jener eines Bilds ist, das erhalten wird, wenn die zweite Linse in der dritten Position ist und der in einem Fokusfensterbereich ist, kleiner als der zweite Kontrast ist; und

Durchführen einer Bildaufnahme in der Zielposition.

6. Verfahren nach einem der Ansprüche 1 bis 5, wobei vor dem Steuern der ersten Linse, um sie zu der Zielposition zu bewegen, das Verfahren ferner umfasst: Bestimmen, dass eine Prüfung der Fokussierungstiefeninformationen erfolgreich ist.

7. Verfahren nach einem der Ansprüche 1 bis 6, wobei, wenn ein menschliches Gesicht in dem Fokusfenster erkannt wird, die Prüfung der Fokussierungstiefeninformationen mithilfe der folgenden Schritte durchgeführt wird:

Schätzen einer geschätzten Entfernung zwischen dem menschlichen Gesicht und der ersten Linse gemäß einer Größe eines Rahmens des menschlichen Gesichts; und

Bestimmen, dass die Prüfung der Fokussierungstiefeninformationen erfolgreich ist, wenn ein Absolutwert einer Differenz zwischen der geschätzten Entfernung und den Fokussierungstiefeninformationen kleiner als oder gleich einem vierten Schwellenwert ist.

8. Elektronische Vorrichtung, umfassend:

eine erste Bildaufnahmeeinheit (201, 401) und eine zweite Bildaufnahmeeinheit (202, 402), die dafür ausgelegt sind, zu einem gleichen Zeitpunkt ein erstes Bild bzw. ein zweites Bild aufzunehmen, die von einem ersten Gegenstand sind;

einen ersten Aktuator; und

einen Prozessor (404), der dafür ausgelegt ist, den ersten Aktuator zu steuern, um ihn zu bewegen, sodass sich die erste Linse zu einer Zielposition bewegt,

dadurch gekennzeichnet, dass der Prozessor ferner dafür ausgelegt ist:

M erste Tiefeninformationselemente von M gleichen Merkmalspunktpaaren in entsprechenden Bereichen in dem ersten Bild und dem zweiten Bild zu berechnen, wobei M eine positive Ganzzahl ist; zu bestimmen, ob die Konfidenz der M ersten Tiefeninformationselemente größer als ein Schwellenwert ist;

Fokussierungstiefeninformationen gemäß N ersten Tiefeninformationselementen in den M ersten Tiefeninformationselementen zu erhalten, wenn die Konfidenz der M ersten Tiefeninformationselemente größer als der Schwellenwert ist, wobei N eine positive Ganzzahl kleiner als oder gleich M ist; und die Zielposition einer ersten Linse der ersten Bildaufnahmeeinheit (201, 401) gemäß den Fokussierungstiefeninformationen zu erhalten.

9. Elektronische Vorrichtung nach Anspruch 8, wobei die entsprechenden Bereiche Bereiche sind, die Positionen von Fokusfenstern entsprechen, wenn das erste Bild und das zweite Bild erfasst werden, wobei ein Bereich in dem ersten Bild ein erster Bereich ist, ein Bereich in dem zweiten Bild ein zweiter Bereich ist und der Prozessor spezifisch dafür ausgelegt ist: zu bestimmen, ob eine Menge an ersten Merkmalspunkten in dem ersten Bereich größer als oder gleich einem ersten Schwellenwert ist, oder zu bestimmen, ob eine Menge an zweiten Merkmalspunkten in dem zweiten Bereich größer als oder gleich einem zweiten Schwellenwert ist, und wenn die Menge an ersten Merkmalspunkten kleiner als der erste Schwellenwert ist und/oder die Menge an zweiten Merkmalspunkten kleiner als der zweite Schwellenwert ist, zu bestimmen, dass die Konfidenz der M ersten Tiefeninformationselemente kleiner als oder gleich dem Schwellenwert ist.

10. Elektronische Vorrichtung nach einem der Ansprüche 8 bis 9, wobei der Prozessor ferner dafür ausgelegt ist: wenn die Menge an ersten Merkmalspunkten größer als oder gleich dem ersten Schwellenwert ist und die Menge an zweiten Merkmalspunkten größer als oder gleich dem zweiten Schwellenwert ist, für die ersten Merkmalspunkte die zweiten Merkmalspunkte in einer ersten Sequenz nach ersten übereinstimmenden Merkmalspunkten abzusuchen, die mit den ersten Merkmalspunkten übereinstimmen, und die zweiten Merkmalspunkte in einer zweiten Sequenz nach zweiten übereinstimmenden Merkmalspunkten abzusuchen, die mit den ersten Merkmalspunkten übereinstimmen, wobei die zweite Sequenz umgekehrt zu der ersten Sequenz ist;

eine Menge an gleichen übereinstimmenden Merkmalspunkten zu bestimmen, die in den ersten übereinstimmenden Merkmalspunkten und den zweiten

übereinstimmenden Merkmalspunkten sind und die einem gleichen Merkmalspunkt in den ersten Merkmalspunkten entsprechen; und
wenn ein Verhältnis der Menge zu der Menge an ersten Merkmalspunkten kleiner als ein dritter Schwellenwert ist, zu bestimmen, dass die Konfidenz der M ersten Tiefeninformationselemente kleiner als oder gleich dem Schwellenwert ist; oder wenn ein Verhältnis der Menge zu der Menge an ersten Merkmalspunkten größer als oder gleich einem dritten Schwellenwert ist, zu bestimmen, dass die Konfidenz der M ersten Tiefeninformationselemente größer als der Schwellenwert ist.

11. Elektronische Vorrichtung nach einem der Ansprüche 8 bis 10, wobei der Prozessor spezifisch dafür ausgelegt ist, die Fokussierungstiefeninformationen gemäß Tiefeninformationen zu erhalten, die dem gleichen Merkmalspunkt entsprechen.

12. Elektronische Vorrichtung nach einem der Ansprüche 8 bis 11, wobei die elektronische Vorrichtung ferner einen zweiten Aktuator umfasst und der Prozessor ferner dafür ausgelegt ist: nach dem Steuern der ersten Linse, um sie zu der Zielposition zu bewegen, den zweiten Aktuator zu steuern, um ihn zu bewegen, sodass eine zweite Linse der zweiten Bildaufnahmeeinheit (202, 402) zu einer dritten Position bewegt wird; zu bestimmen, dass eine Prüfung der Fokussierungstiefeninformationen Erfolg hat, wenn ein erster Kontrast, der jener eines Bilds ist, das erhalten wird, bevor sich die erste Linse zu der Zielposition bewegt, und der in einem Fokusfensterbereich ist, kleiner als ein zweiter Kontrast ist, der jener eines Bilds ist, das erhalten wird, wenn die erste Linse in der Zielposition ist, und der in einem Fokusfensterbereich ist, und ein dritter Kontrast, der jener eines Bilds ist, das erhalten wird, wenn die zweite Linse in der dritten Position ist, und der in einem Fokusfensterbereich ist, kleiner als der zweite Kontrast ist; und das Durchführen der Bildaufnahme in der Zielposition zu steuern.

13. Elektronische Vorrichtung nach einem der Ansprüche 8 bis 12, wobei der Prozessor ferner dafür ausgelegt ist: vor dem Steuern der ersten Linse, um sie zu der Zielposition zu bewegen, zu bestimmen, dass eine Prüfung der Fokussierungstiefeninformationen erfolgreich ist.

14. Elektronische Vorrichtung nach einem der Ansprüche 8 bis 13, wobei der Prozessor spezifisch dafür ausgelegt ist: wenn ein menschliches Gesicht in dem Fokusfenster erkannt wird, eine geschätzten Entfernung zwischen dem menschlichen Gesicht und der ersten Linse gemäß einer Größe eines Rahmens des menschlichen Gesichts zu schätzen; und zu bestimmen, dass die Prüfung der Fokussierungstiefeninformationen erfolgreich ist, wenn ein Absolutwert einer Differenz zwischen der geschätzten Entfernung und den Fokussierungstiefeninformationen kleiner als oder gleich einem vierten Schwellenwert ist.

Revendications

1. Procédé de mise au point automatique consistant :

au même moment, à collecter (101) une première image d'un premier objet en utilisant une première unité de prise de vues d'image (201, 401) et à collecter une seconde image du premier objet en utilisant une seconde unité de prise de vues d'image (202, 402) ; et
à obtenir (105) une position cible d'une première lentille de la première unité de prise de vues d'image en fonction d'informations de profondeur de mise au point et à commander la première lentille pour se déplacer jusqu'à la position cible **caractérisé en ce que** le procédé consiste en outre :

à calculer (102) M éléments de premières informations de profondeur de M paires de mêmes points caractéristiques dans des zones correspondantes dans la première image et la seconde image, dans lequel M est un nombre entier positif ;
à déterminer (103) si le niveau de confiance des M éléments de premières informations de profondeur est supérieur à un seuil ; et
à obtenir (104) des informations de profondeur de mise au point en fonction de N éléments de premières informations de profondeur dans les M éléments de premières informations de profondeur lorsque le niveau de confiance des M éléments de premières informations de profondeur est supérieur au seuil, dans lequel N est un nombre entier positif inférieur ou égal à M.

2. Procédé selon la revendication 1, dans lequel les zones correspondantes sont des zones correspondant à des positions de fenêtres de mise au point lorsque la première image et la seconde image sont collectées, une zone dans la première image est une première zone, une zone dans la seconde image est une seconde zone, et la détermination que le niveau de confiance des M éléments de premières informations de profondeur est supérieur à un seuil consiste : à déterminer si une quantité de premiers points caractéristiques dans la première zone est supérieure ou égale à un premier seuil ou à déterminer si une quantité de seconds points caractéristiques dans la seconde zone est supérieure ou égale à un deuxième seuil et, lorsque la quantité de premiers points caractéristiques est inférieure au premier seuil et/ou que la quantité de seconds points caractéristiques est inférieure au deuxième seuil, à déterminer que le niveau de confiance des M éléments de premières informations de profondeur est inférieur ou égal au seuil.

3. Procédé selon l'une quelconque des revendications 1 à 2, dans lequel, lorsque la quantité de premiers points caractéristiques est supérieure ou égale au premier seuil et que la quantité de seconds points caractéristiques est supérieure ou égale au deuxième seuil, le procédé consiste en outre :

pour les premiers points caractéristiques, à rechercher les seconds points caractéristiques dans une première séquence pour des premiers points caractéristiques de correspondance qui correspondent aux premiers points caractéristiques, et à rechercher les seconds points caractéristiques dans une seconde séquence pour des seconds points caractéristiques de correspondance qui correspondent aux premiers points caractéristiques, dans lequel la seconde séquence est l'inverse de la première séquence ;
à déterminer une quantité de mêmes points caractéristiques de correspondance qui sont dans les premiers points caractéristiques de correspondance et dans les seconds points caractéristiques de correspondance et qui correspondent à un même point caractéristique dans les premiers points caractéristiques ; et
lorsqu'une proportion entre la quantité et la quantité de premiers points caractéristiques est inférieure à un troisième seuil, à déterminer que le niveau de confiance des M éléments de premières informations de profondeur est inférieur ou égal au seuil ; ou
lorsqu'une proportion entre la quantité et la quantité de premiers points caractéristiques est supérieure ou égale à un troisième seuil, à déterminer que le niveau de confiance des M éléments de premières informations de profondeur est supérieur au seuil.

4. Procédé selon l'une quelconque des revendications 1 à 3, dans lequel l'obtention d'informations de profondeur de mise au point en fonction de N éléments de premières informations de profondeur dans les M éléments de premières informations de profondeur consiste :
à obtenir les informations de profondeur de mise au point en fonction d'informations de profondeur correspondant au même point caractéristique.

5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel, après la commande de la première lentille pour se déplacer jusqu'à la position cible, le procédé consiste en outre :

à commander une seconde lentille de la seconde unité de prise de vues d'image (202, 402) pour se déplacer jusqu'à une troisième position ;
à déterminer qu'une vérification concernant les informations de profondeur de mise au point réussit lorsqu'un premier contraste qui provient d'une image obtenue avant que la première lentille ne se déplace jusqu'à la position cible et qui se trouve dans une zone de fenêtre de mise au point, est inférieur à un deuxième contraste qui provient d'une image obtenue lorsque la première lentille se trouve à la position cible et qui se trouve dans une zone de fenêtre de mise au point, et un troisième contraste qui provient d'une image obtenue lorsque la seconde lentille se trouve à la troisième position et qui se trouve dans une zone de fenêtre de mise au point, est inférieur au deuxième contraste ; et
à effectuer une prise de vues d'image à la position cible.

6. Procédé selon l'une quelconque des revendications 1 à 5, dans lequel, avant la commande de la première lentille pour se déplacer jusqu'à la position cible, le procédé consiste en outre :
à déterminer qu'une vérification concernant les informations de profondeur de mise au point est réussie.

7. Procédé selon l'une quelconque des revendications 1 à 6, dans lequel, lorsqu'un visage humain est détecté dans la fenêtre de mise au point, la vérification est réalisée sur les informations de profondeur de mise au point en utilisant les étapes suivantes consistant :

à estimer une distance estimée entre le visage humain et la première lentille en fonction d'une taille d'un cadre de visage humain ; et
à déterminer que la vérification concernant les informations de profondeur de mise au point est réussie lorsqu'une valeur absolue d'une différence entre la distance estimée et les informations de profondeur de mise au point est inférieure ou égale à un quatrième seuil.

8. Dispositif électronique comprenant :

une première unité de prise de vues d'image (201, 401) et une seconde unité de prise de vues d'image (202, 402), configurées pour collecter respectivement, au même moment, une première image et une seconde image qui sont d'un premier objet ;

un premier actionneur ; et
un processeur (404), configuré pour commander le premier actionneur pour se déplacer de telle sorte que la première lentille se déplace jusqu'à une position cible, **caractérisé en ce que** le processeur est en outre configuré :

pour calculer M éléments de premières informations de profondeur de M paires de mêmes points caractéristiques dans des zones correspondantes dans la première image et la seconde image, dans lequel M est un nombre entier positif ; pour déterminer si le niveau de confiance des M éléments de premières informations de profondeur est supérieur à un seuil ;
pour obtenir des informations de profondeur de mise au point en fonction de N éléments de premières informations de profondeur dans les M éléments de premières informations de profondeur lorsque le niveau de confiance des M éléments de premières informations de profondeur est supérieur au seuil, dans lequel N est un nombre entier positif inférieur ou égal à M ; et
à obtenir la position cible d'une première lentille de la première unité de prise de vues d'image (201, 401) en fonction des informations de profondeur de mise au point.

9. Dispositif électronique selon la revendication 8, dans lequel les zones correspondantes sont des zones correspondant à des positions de fenêtres de mise au point lorsque la première image et la seconde image sont collectées, une zone dans la première image est une première zone, une zone dans la seconde image est une seconde zone, et le processeur est spécialement configuré : pour déterminer si une quantité de premiers points caractéristiques dans la première zone est supérieure ou égale à un premier seuil ou pour déterminer si une quantité de seconds points caractéristiques dans la seconde zone est supérieure ou égale à un deuxième seuil et, lorsque la quantité de premiers points caractéristiques est inférieure au premier seuil et/ou que la quantité de seconds points caractéristiques est inférieure au deuxième seuil, pour déterminer que le niveau de confiance des M éléments de premières informations de profondeur est inférieur ou égal au seuil.

10. Dispositif électronique selon l'une quelconque des revendications 8 à 9, dans lequel le processeur est en outre configuré : lorsque la quantité de premiers points caractéristiques est supérieure ou égale au premier seuil et que la quantité de seconds points caractéristiques est supérieure ou égale au deuxième seuil, pour les premiers points caractéristiques, pour rechercher les seconds points caractéristiques dans une première séquence pour des premiers points caractéristiques de correspondance qui correspondent aux premiers points caractéristiques, et pour rechercher les seconds points caractéristiques dans une seconde séquence pour des seconds points caractéristiques de correspondance qui correspondent aux premiers points caractéristiques, dans lequel la seconde séquence est l'inverse de la première séquence ;
pour déterminer une quantité de mêmes points caractéristiques de correspondance qui sont dans les premiers points caractéristiques de correspondance et dans les seconds points caractéristiques de correspondance et qui correspondent à un même point caractéristique dans les premiers points caractéristiques ; et
lorsqu'une proportion entre la quantité et la quantité de premiers points caractéristiques est inférieure à un troisième seuil, pour déterminer que le niveau de confiance des M éléments de premières informations de profondeur est inférieur ou égal au seuil ; ou lorsqu'une proportion entre la quantité et la quantité de premiers points caractéristiques est supérieure ou égale à un troisième seuil, pour déterminer que le niveau de confiance des M éléments de premières informations de profondeur est supérieur au seuil.

11. Dispositif électronique selon l'une quelconque des revendications 8 à 10, dans lequel le processeur est spécialement configuré pour obtenir les informations de profondeur de mise au point en fonction d'informations de profondeur correspondant au même point caractéristique.

12. Dispositif électronique selon l'une quelconque des revendications 8 à 11, dans lequel le dispositif électronique comprend en outre un second actionneur, et le processeur est en outre configuré : après la commande de la première lentille pour se déplacer jusqu'à la position cible, pour commander le second actionneur pour se déplacer, de sorte à déplacer une seconde lentille de la seconde unité de prise de vues d'image (202, 402) jusqu'à une troisième position ; pour déterminer qu'une vérification concernant les informations de profondeur de mise au point réussit lorsqu'un premier contraste qui provient d'une image obtenue avant que la première lentille ne se déplace jusqu'à la position cible et qui se trouve dans une zone de fenêtre de mise au point, est inférieur à un deuxième contraste qui provient d'une image obtenue lorsque la première lentille se trouve à la position cible et qui se trouve dans une zone de fenêtre de mise au point, et un troisième contraste qui provient d'une image obtenue lorsque la seconde lentille se trouve à la troisième position et qui se trouve dans une zone de fenêtre de mise au point, est inférieur au deuxième contraste ; et pour commander la réalisation d'une prise de vues d'image à la position cible.

13. Dispositif électronique selon l'une quelconque des revendications 8 à 12, dans lequel le processeur est en outre configuré : avant la commande de la première lentille pour se déplacer jusqu'à la position cible, pour déterminer qu'une vérification concernant les informations de profondeur de mise au point est réussie.

14. Dispositif électronique selon l'une quelconque des revendications 8 à 13, dans lequel le processeur est spécialement configuré : lorsqu'un visage humain est détecté dans la fenêtre de mise au point, pour estimer une distance estimée entre le visage humain et la première lentille en fonction d'une taille d'un cadre de visage humain ; et pour déterminer que la vérification concernant les informations de profondeur de mise au point est réussie lorsqu'une valeur absolue d'une différence entre la distance estimée et les informations de profondeur de mise au point est inférieure ou égale à un quatrième seuil.

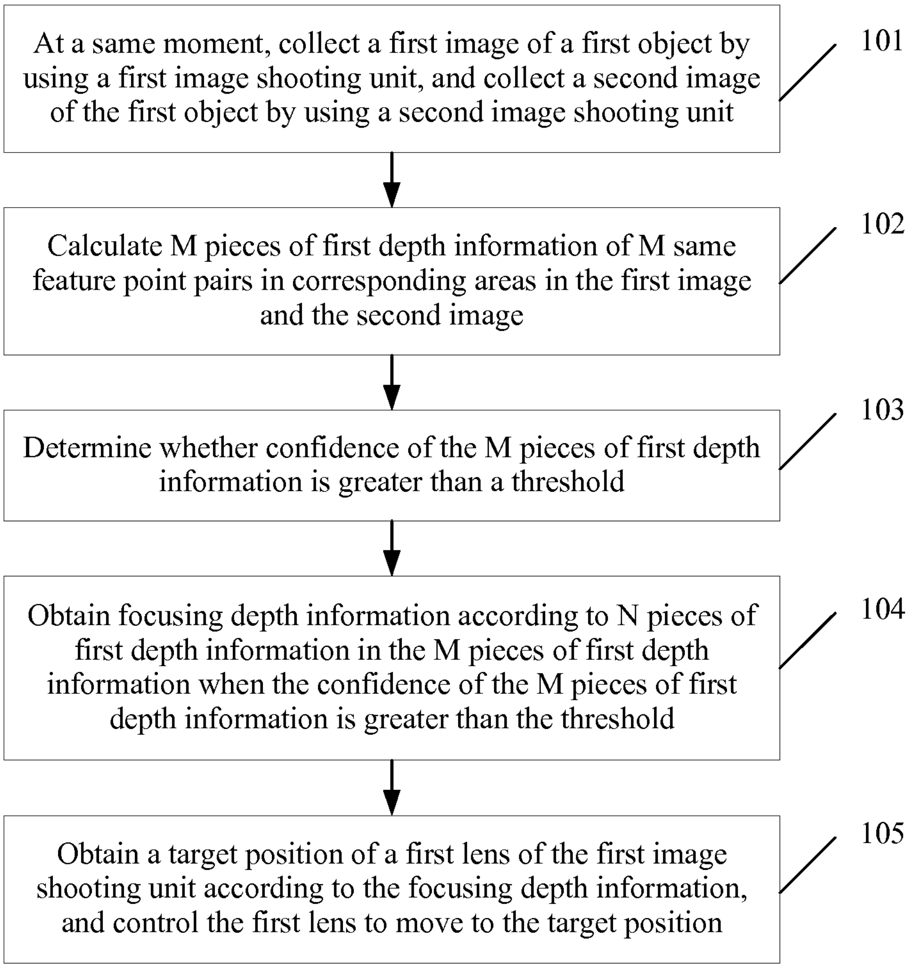
At a same moment, collect a first image of a first object by using a first image shooting unit, and collect a second image of the first object by using a second image shooting unit
101
Calculate M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image
102
Determine whether confidence of the M pieces of first depth information is greater than a threshold
103
Obtain focusing depth information according to N pieces of first depth information in the M pieces of first depth information when the confidence of the M pieces of first depth information is greater than the threshold
104
Obtain a target position of a first lens of the first image shooting unit according to the focusing depth information, and control the first lens to move to the target position
105

FIG. 1

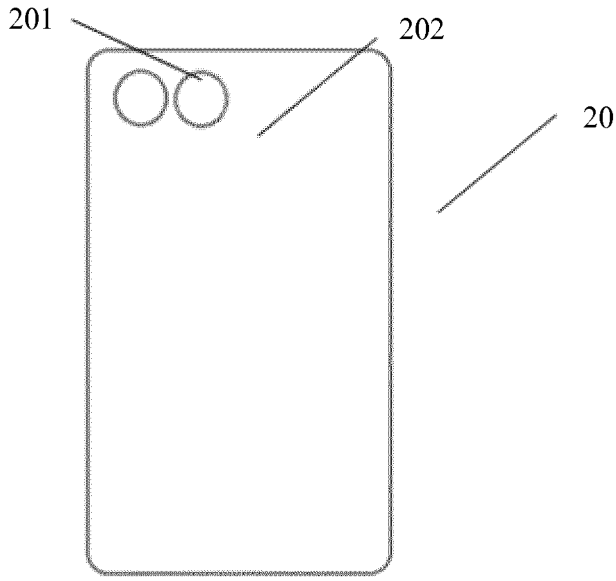

FIG. 2

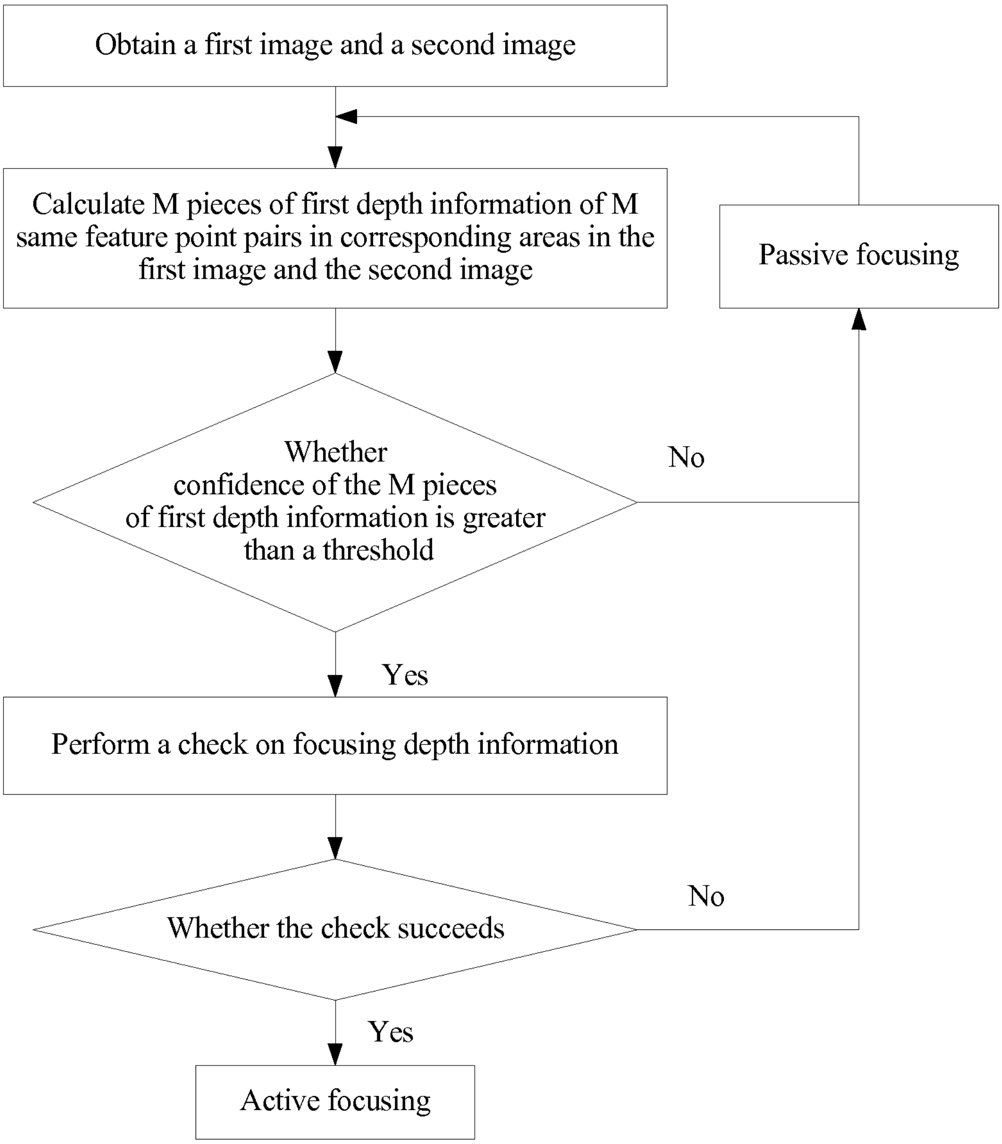
Obtain a first image and a second image
Calculate M pieces of first depth information of M same feature point pairs in corresponding areas in the first image and the second image
Passive focusing
Whether confidence of the M pieces of first depth information is greater than a threshold
No
Yes
Perform a check on focusing depth information
Whether the check succeeds
No
Yes
Active focusing

FIG. 3

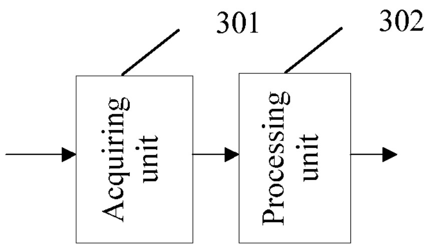
301
302
Acquiring unit
Processing unit

FIG. 4

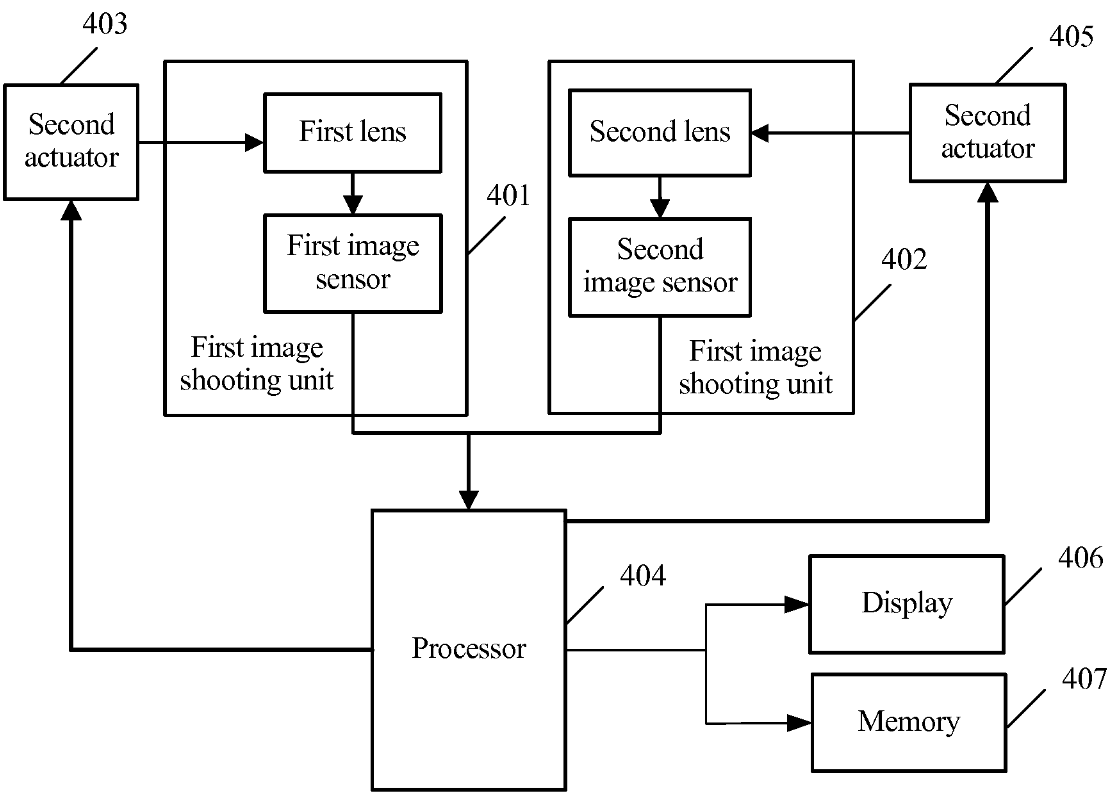
403
Second actuator
First lens
First image sensor
401
First image shooting unit
Second lens
Second image sensor
402
First image shooting unit
405
Second actuator
Processor
404
Display
406
Memory
407

FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2013146996 A1 **[0003]**
- WO 2014044126 A1 **[0003]**
- US 2014210953 A1 **[0003]**